Research on Development of ETindex Map as a GCOM-C Land Product - JFY2021

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Research background:

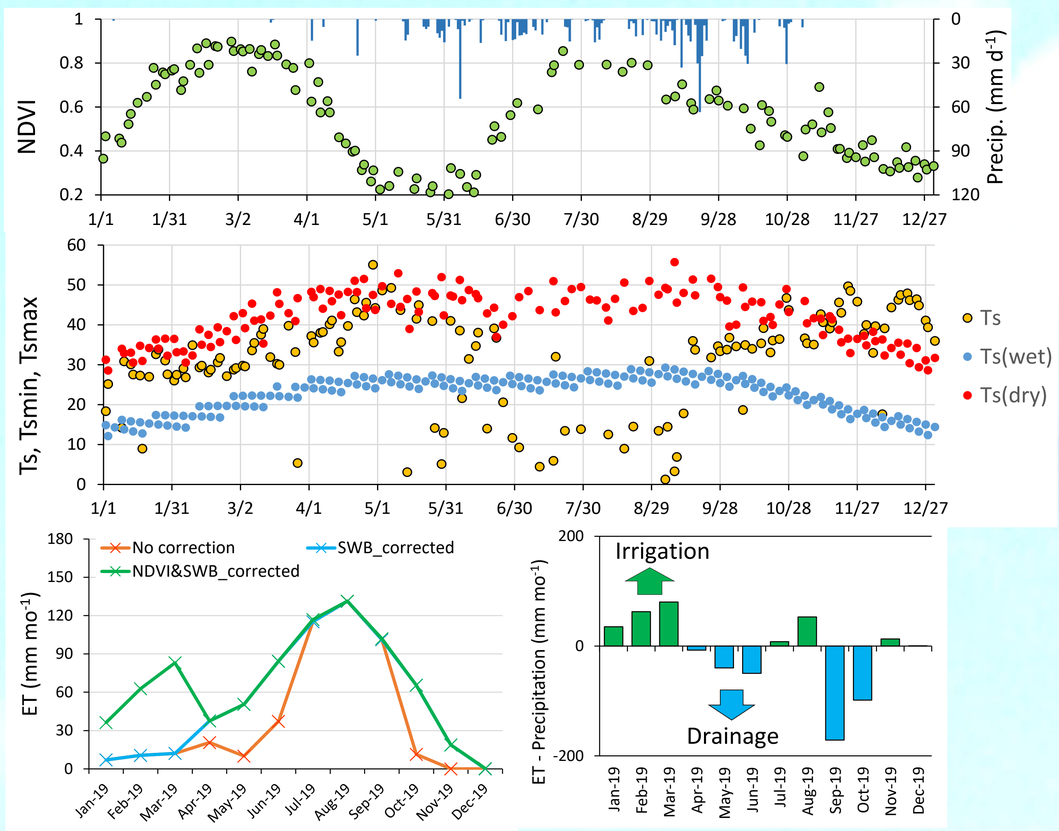
(1) Evapotranspiration (ET) is a key element of the hydrologic cycle. ET rates strongly influence vegetation distribution, crop production and crop water requirements. → Global ET product is of great value in the fields of agriculture, hydrology, climate change, and environmental management.
(2) GCOM-C SGLI can supply reliable ET information worldwide, with a unique spatial resolution (250m thermal).

This Year's Research Schedule (JFY 2021)

(1) ETindex algorithm tuning, adjustments for GCOM-C LST product.
(2) ETindex algorithm accuracy assessment.
(3) Suggestions for operational application ideas.

1. Algorithm updates

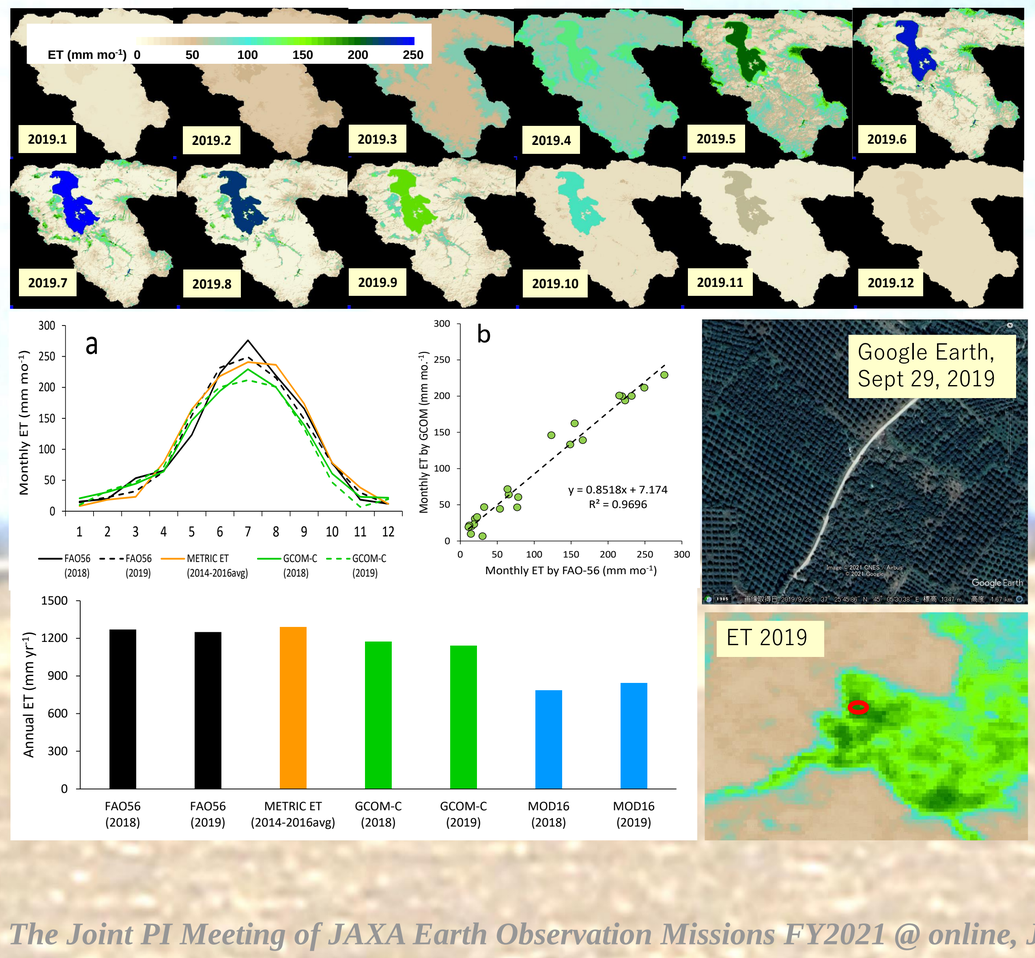
Algorithm has updated to solve a malfunction occurred in some tropic regions. Following is an application example in paddy-rice double crop near Bangkok, Thailand, in 2019.



The algorithm relies reference temperatures (i.e. cold and hot temperatures) on solar-radiation intensity. One key equation was developed based on analysis by mid-latitude area, which did not work in some tropical areas. Soil Water Balance (SWB) and NDVI adjustments empirically avoids the problem.
ET estimated with updated algorithm captured EY from Jan.-March paddy rice cultivation by irrigation. The resulted ET information can be used for analyzing regional water balance and agricultural water requirements.

2. Accuracy assessment

Evapotranspiration map for Urmia Lake Basin of Iran was evaluated by comparing with independent estimated results and MODIS MOD16 Evapotranspiration product. Estimation error was evaluated as less than 10% (annual) or about 15% (monthly) in irrigation agriculture. The error range was comparable to ground-based observation error (up to 20%), and was superior to MOD16 (35%) in the region. Details are found in Tasumi and Moriyama (2022), "Evapotranspiration estimation of Urmia Lake Basin using GCOM-C thermal imagery" (IOP Conf. Series: Earth and Environmental Science 958 (2022) 012010, doi:10.1088/1755-1315/958/1/012010).



3. Communications

Presented application examples and ideas of evapotranspiration map, at two UN workshops:
- FAO Webinar "Remote sensing determination of evapotranspiration" (2021/4/7)
- UNOOSA Workshop "Space tech. app. for drought, flood and water resources mngt." (2021/8/9)

4. Development of reference evapotranspiration map (New)

"Reference evapotranspiration (ETo)" suggested by FAO, is an intermediate data of ET estimation with ETindex algorithm. Also, ETo is a valuable information, since a large number of irrigation engineers use for their operational purposes. Automated estimation of ETo, using GCOM-C Solar Radiation Product, has started investigating with Dr. Moriyama of Nagasaki Univ. It may be distributed as an additional layer of ETindex product in future.

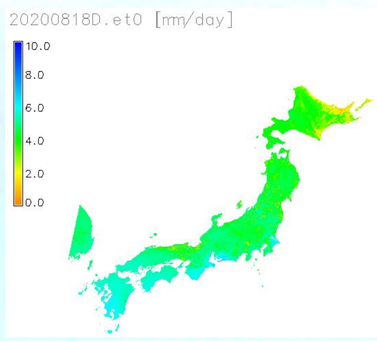


Fig: Estimated ETo map of 2020/8/18

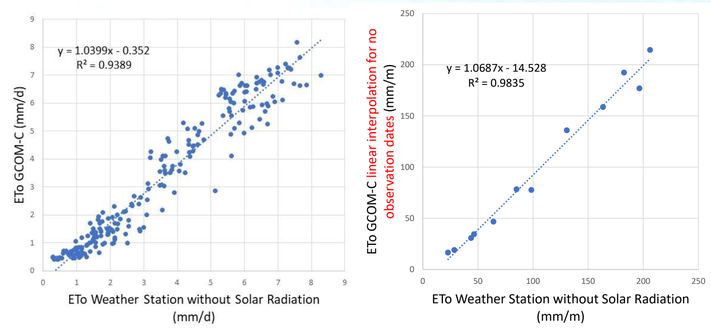


Fig: Comparison of estimated ETo with ground-measured ETo in Urmia, Iran; Left = 2019 daily values for satellite image acquisition dates; Right = 2019 monthly values

Three Years' Research Schedule (JFY 2019-2021)

(1) ETindex algorithm tuning for GCOM-C LST product.
(2) ETindex algorithm accuracy assessment.
(3) Algorithm refinement.
(4) Suggestions for operational application ideas.
(5) Communications with related researchers/institutions.

5. Publications in three years

1. Application of GCOM-C SGLI for agricultural water management via field evapotranspiration. Tasumi, M., Moriyama, M., Shinohara, Y. 2019. *Paddy and Water Environment,* 17:2:75-82.
2. Application of the GCOM-C global ETindex estimation algorithm in 40 forests located throughout Japan, North America, Australia, and the tropical region. Umeno, H., Shinohara, Y., Tasumi, M. 2019. *Journal of Agricultural Meteorology*, 75:193-202.
3. Application of Scintillometer for Evaluating the Performance of GCOM-C ETindex Estimation Algorithm at a Forest Site. Denih, A., Tasumi, M., et. al. 2019. *J. Rainwater Catchment Sys.,* 24:2:27-32.
4. Estimating evapotranspiration using METRIC model and Landsat data for better understandings of regional hydrology in the western Urmia Lake Basin. Tasumi, M. 2019. *Ag. Water Mang.*, 226:105805.
5. Evapotranspiration estimation of Urmia Lake Basin using GCOM-C thermal imagery. Tasumi, M., Moriyama, M. 2022. IOP Conf. Series: Earth and Environmental Science 958, 012010.
6. GCOM-C(しきさい)による蒸発散に基づいた灌漑施設の精緻な稼働状況の可視化. 森山雅雄・多炭雅博・遠藤貴宏. 2022.写真測量とリモートセンシング(印刷中)

6. Brief history for the three years' activities

The primary input data of ETindex algorithm is GCOM-C LST product. The three years' research was started from better understanding of the new GCOM-C LST product. Some suggestions for LST product were made from user-side.

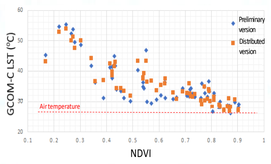


Fig: Change of GCOM-C LST values between preliminary and distributed versions (western US agriculture).

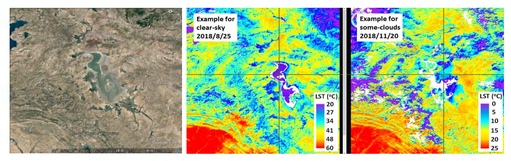


Fig: Geolocation shift of cloud-cover pixels, caused by geolocation problem. (Urmia, Iran)

Seq. #	1	2	3	4	5	6	7	8
Date	5/25	5/26	5/27	5/28	5/29	5/30	5/31	6/1
SGLI LST (K)	271.2	-999.0	-999.0	-999.0	270.1	-999.0	-999.0	-999.0
Seq. #	9	10	11	12	13	14	15	16
Date	6/2	6/3	6/4	6/5	6/6	6/7	6/8	6/9
SGLI LST (K)	306.4	322.3	-999.0	-999.0	-999.0	-999.0	-999.0	309.0

Fig: Data availability and cloud contamination in LST product (Tokyo, Japan)

The primary algorithm refinement was integration of soil water balance model. In addition, tuning for cloud-free composite was made. Test applications were made for several locations in the world.

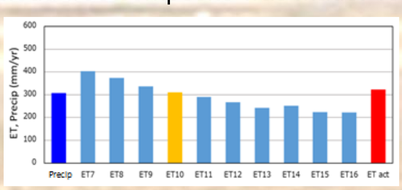


Fig: Impact of unit-duration for cloud-free composite.

Comparison were made with ground-measured data, independently estimated data, literature values, and MODIS MOD 16 products. The results were summarized in the papers listed above.

The Joint PI Meeting of JAXA Earth Observation Missions FY2021 @ online, Jan.17-21, 2022.